UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010

GROUND-WATER QUALITY ASSESSMENT PLAN NO. 38-26-0441-84
REDSTONE ARSENAL, ALABAMA
26-29 SEPTEMBER 1983

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

Mr. Fox/slw/AUTOVON
584-2024

REPLY TO
ATTENTION OF

HSHB-ES-G/WP

14 MAR 1984

SUBJECT: Ground-water Quality Assessment Plan No. 38-26-0441-84, Redstone Arsenal, Alabama, 26-29 September 1983

Commander
US Army Materiel Development
and Readiness Command
ATTN: DRCSG
5001 Eisenhower Avenue
Alexandria, VA 22333

1. The purpose of this effort was to develop a ground-water quality assessment plan for detailed field study pursuant to regulatory requirements. The plan will enable definition of the ground-water contamination problem to include the rate, extent of migration, and concentration of hazardous wastes or hazardous waste constituents in the ground water.

2. The plan for the ground-water quality assessment includes a phased approach involving extensive chemical analyses of ground-water samples and the drilling of new monitoring wells.

3. Implementation of this ground-water quality assessment will be through normal command channels. The entire study will be accomplished by this Agency.

FOR THE COMMANDER:

NELSON H. LUND, P.E.
Colonel, MSC
Director, Environmental Quality

1 Incl
as

CF:
Cdr, HSC (HSCL-P)
Cdr, MICOM (2 cy)
Cdr, DARCOMI&SA (DRCIS-RI-IC) (2 cy)
Cdr, Redstone Arsenal Spt Actv (6)

CONTENTS

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HSHB-ES-G/WP

GROUND-WATER QUALITY ASSESSMENT PLAN NO. 38-26-0441-84
REDSTONE ARSENAL, ALABAMA
26-29 SEPTEMBER 1983

1. AUTHORITY. Letter, DRCIS-A, HQ DARCOM, 9 September 1983, subject: Resource Conservation and Recovery Act.

2. REFERENCES. See Appendix A for a listing of references.

3. PURPOSE. To develop a ground-water quality assessment plan in accordance with reference 1. The plan will enable definition of the ground-water contamination problem to include the rate, extent of migration, and concentration of hazardous wastes or hazardous waste constituents in the ground water.

4. GENERAL.

a. Personnel Contacted.

(1) Mr. M. William Schroder, Environmental Coordinator, Facilities Engineering Division, Redstone Arsenal.

(2) Mr. Ronald Hagler, Ecologist, Facilities Engineering Division, Redstone Arsenal.

(3) Mr. Paul Moser, Environmental Geologist, Water Resources Division, Geological Survey of Alabama.

b. Location and Mission. Redstone Arsenal is located to the southwest of Huntsville, Alabama, in the southwest part of Madison County. The installation is bounded by the Tennessee River on the south and occupies 60.4 square miles. Redstone Arsenal's primary mission is to develop, manufacture, and test rocket motors and missiles. Training for personnel in the use of missile systems and munition materiel is conducted by the US Army Missile and Munition Center and School. The Marshall Space Flight Center National Aeronautics and Space Administration which is a tenant activity at Redstone Arsenal, researches, develops, tests, and manufactures space vehicles and components.

c. DDT Hazardous Waste Landfill Description. The DDT Hazardous Waste Landfill was constructed in 1979 and operated from July 1979 to August 1982. The DDT-contaminated materials from the former DDT manufacturing area, the DDT drainage ditch, and former DDT disposal sites were excavated and placed in the landfill. The DDT Hazardous Waste Landfill is located near the center of Redstone Arsenal in the northwest corner of the Sanitary Landfill Area as shown in Figure 1. The construction details for the DDT Hazardous Waste Landfill are shown in Appendix B. Only pits 4, 5, and 6 were utilized for disposal of approximately 10,000 cubic yards of DDT-contaminated materials. The volumes placed in each pit were: Pit 4 - 1,000 cubic yards, Pit 5 - 5,000 cubic yards, and Pit 6 - 4,000 cubic yards.

5. FINDINGS AND DISCUSSION.

a. Regional Geohydrology.

(1) Topography. Redstone Arsenal lies within the Highland Rim Section of the Interior Low Plateau. In general, the topography is gently rolling, with elevations ranging predominantly between 600 and 650 feet above mean sea level. Two areas have pinnacle-shaped mountains which are located in the north-central (1,239 feet) and southwest (830 feet) parts of the arsenal.

(2) Regional Geology. Bedrock at Redstone Arsenal is Mississippian in age and consists predominantly of limestone with some sandstone and chert. The bedrock has a gentle dip to the southeast and has extensive joints and bedding planes. Table 1 describes the bedrock formations present at Redstone Arsenal, and Figure 2 shows the areal extent of these formations. The Tuscumbia limestone, the most extensive bedrock unit on the arsenal, displays the solution channels and caves typical of karst development. A residual soil or regolith has formed over most of the arsenal as a result of weathering of the bedrock formations. The soluble material in limestone bedrock has been removed, leaving an insoluble residue of clay, sand, and chert above the bedrock. The predominant soil at the arsenal is clay and silty clay, with lenses of sand and chert.

(3) Regional Ground Water. The major water-producing aquifer on the arsenal is the Tuscumbia limestone. The regional ground-water flow direction is south towards Huntsville Spring Branch and the Tennessee River. Ground water in limestone occurs in fractures and bedding planes that may be enlarged by solution weathering. The solution channels serve as conduits for the movement of large quantities of ground water. The Tuscumbia limestone aquifer is the source of ground water for several large-capacity wells located immediately west of the arsenal. A shallow water table aquifier in the residual overburdan is present over most of the installation. Much of this overburden is low-permeability clay with some lenses of water-bearing sand. The clay may act as a confining bed for local artesian or perched water table conditions.

b. Local Geohydrology. The DDT Hazardous Waste Landfill lies on a local topographic high area as shown in Figure 1. Eight bore holes (RS007 to RS014) were drilled to define the subsurface material at the site when it was proposed in 1978. Monitoring wells were constructed in bore holes RS010 and RS011. After the permit was approved, five additional bore holes (RS015 to RS019) were drilled for placement of two additional monitoring wells (RS015 and RS016) and eight suction lysimeters (RS017 to RS019). Locations and drilling logs for all test borings, monitoring wells, and lysimeters are shown in Appendix C. Clay and silty or sandy clay are the dominant materials in all the borings, with the plasticity increasing with depth. Small sand lenses and chert zones were common, and larger sand lenses were encountered in bore holes RS007, RS008, RS011, and RS018. Analyses of soil samples for physical properties are provided in Appendix D.

TABLE 1. BEDROCK GEOLOGY OF REDSTONE ARSENAL, ALABAMA*

Period	Formation	Lithology	Thickness
Mississippian	Bangor Limestone	Light-to-medium gray, massively bedded, fossiliferous limestone. Thin beds of grayish-green and moderate red shale and light-gray dolomitic limestone occur in the upper part.	400-500 feet
	Hartselle Sandstone	Light-gray and very pale orange sandstone, cross-bedded in part, interbedded with grayish-green and light-gray fossiliferous shale and occasionally sandy, fossiliferous limestone.	< 80 feet
	Pride Mountain Formation	Light greenish-gray and pale yellowish brown fossiliferous shale with thin interbeds of clayey fossiliferous limestone. Mapped with the underlying Monteagle Limestone.	10-22 feet
	Monteagle Limestone	Light-gray, fossiliferous, crystalline and oolitic limestone with thin interbeds of fossiliferous shale and minor amounts of chert.	200-220 feet
	Tuscumbia Limestone	Light-gray to light-brownish gray fossiliferous limestone containing chert lenses and nodules.	150 feet average
	Fort Payne Chert	Very-light gray to light-gray fossiliferous limestone, siliceous and dolomitic limestone, and dolostone with thin beds of nodular chert.	155-185 feet
Devonian	Chattanooga Shale	Dark gray to black fossiliferous shale with a discontinuous sandstone at the base.	10 feet

* Source - Reference 2.

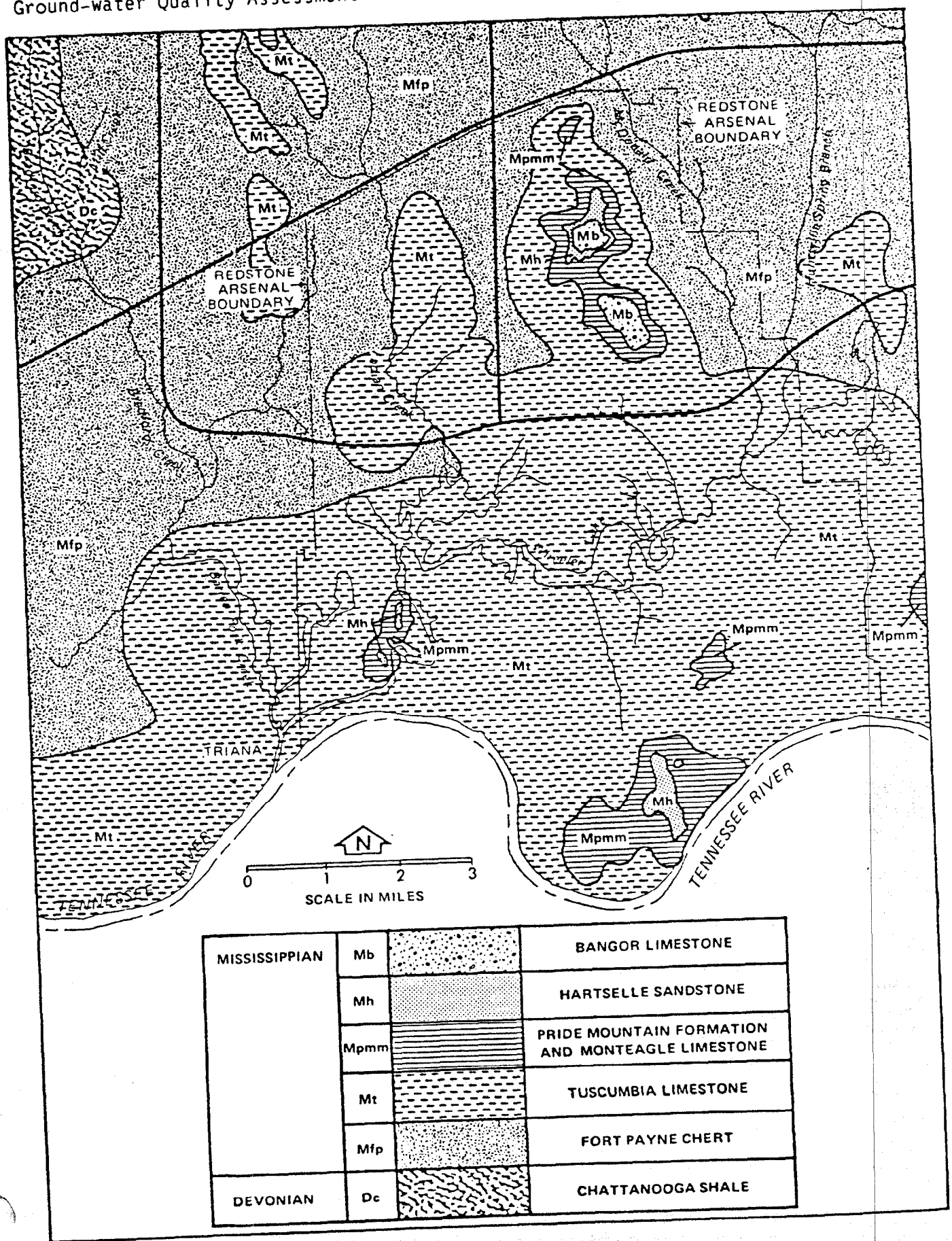


FIGURE 2. Bedrock Geology of Redstone Arsenal (Source: reference 2).

Four monitoring wells were used to assess the ground-water properties of this landfill. Monitoring well RS011 had a perched water table in the silty sand horizon underlain by a high plasticity clay; therefore, RS011 was not used to determine ground-water flow direction. Based on water levels in RS010, RS015, and RS016, the general ground-water flow direction is to the south and Huntsville Spring Branch. All monitoring well and lysimeter construction details are provided in Appendix E. Additional monitoring wells will be constructed at the DDT Hazardous Waste Landfill in the fall of 1983, as required by the State of Alabama (reference 8).

c. Ground-water Quality at the DDT Hazardous Waste Landfill. Ground-water samples had been taken from monitoring wells RS010, RS011, RS015, and RS016 to characterize ground-water quality at the DDT Hazardous Waste Landfill. Ground-water quality results from these samples are found in references 3, 4, and 5. The DDT concentrations in the ground water adjacent to the DDT Hazardous Waste Landfill are shown in Table 2. Monitoring well RS016 is adjacent to a surface drainage ditch and has an inadequate cement seal around the well casing; therefore, the ground-water quality data from RS016 are considered unreliable and the Alabama Department of Environmental Management has recommended pulling and plugging of this monitoring well.

TABLE 2. GROUND-WATER QUALITY RESULTS FOR DDT

	Concentration DDTR* (µg/L)			
Sample Date	Well No. 10	Well No. 11	Well No. 15	Well No. 16
November 1981	0.168	ND	ND	†
February 1982	0.232	ND	ND	9.83
May 1982	0.372	0.178	ND	17.68
August 1982	0.264	0.194	ND	14.78
November 1982	0.607	2.02	ND	7.95
June 1983	0.492	0.126	0.72	3.8

* DDTR includes the sum of concentrations for these isomers: o,p' DDE; p,p' DDE; o,p' DDD; p,p' DDD; o,p' DDT; and p,p' DDT. Isomer detection limit is 0.02 µg/L for clean samples.
† No sample due to broken pipe
ND - not detected

d. Plan of Action.

(1) Phase 1.

(a) Phase 1 of the ground-water quality assessment will include chemical analysis of ground-water samples from all existing and recently installed (~~winter~~ Spring 1984) monitoring wells at the DDT Hazardous Waste Landfill (see Figure 1). Two rounds of sampling will be conducted, with the first round for contaminant detection and the second round for confirmation of first round results. These sampling rounds will be separated by a time period of 1 month. DDT and its isomers are the only hazardous wastes or hazardous waste constituents at the site; therefore, chemical analyses will be restricted to those parameters. Appendix F contains instructions for collection, preparation, and chemical analysis of ground-water samples. Sampling and chemical analysis will be performed by Redstone Arsenal personnel. The Redstone Arsenal laboratory is certified by the State of Alabama for analysis of DDT and its isomers.

(b) The rate of ground-water movement will be calculated using soils laboratory permeability and porosity data and the ground-water gradient at the hazardous waste site. The extent of migration of hazardous wastes will be based on the existing network of monitoring wells. If the extent of migration of hazardous wastes is beyond the area covered by existing monitoring wells at a concentration considered significant by the State of Alabama, the Phase 2 program described below will be initiated.

(c) This Agency will evaluate the data from Phase 1 and submit a report through appropriate command channels to Redstone Arsenal which will subsequently submit the data to the State of Alabama Department of Environmental Management.

(2) Phase 2. Ground-water flow from the DDT Hazardous Waste Landfill is south toward Huntsville Spring Branch and the central part of the Sanitary Landfill Area. Additional monitoring wells will be drilled in the area northwest of the active sanitary landfill trench, and all monitoring wells around the Sanitary Landfill (see Figure 1) and Phase 1 wells will be included for definition of ground-water quality. The monitoring wells will be drilled into the uppermost aquifer; however, the number and location of the wells will not be determined until the conclusion of Phase 1.

(a) Drilling Method. The drilling of the wells will be performed using a hollow-stem auger rig.

(b) Well Specifications. The well casing will be schedule 40, 4-inch-inside diameter (ID) polyvinyl chloride (PVC) pipe with threaded joints. The well screen will be preslotted 4-inch-ID PVC pipe with a slot size of 0.006 inch. The well screen will be 15 feet in length and will be set in the top 15 feet of the uppermost aquifer.

(c) Sandpack, Seal, and Grout. A uniform and complete filling of the annular space with sandpack, bentonite pellets, and grout will be achieved. The sand will be clean, texturally larger than the slot size of the screen, and fill the annular space to approximately 3 feet above the top of the screen. A bentonite seal will be installed above the sandpack. The seal should be 2 feet of tamped bentonite-water mixture (bentonite pellets will be used because bentonite powder will bridge the annular space as soon as it contacts moisture). A grout mixture of premixed cement, 3-percent bentonite powder, and water will then be placed into the annular space from the top of the bentonite seal to the ground surface.

(d) Well Protection. Each well will be capped with a vented PVC cap. A protective casing, a section of steel pipe larger in diameter than the PVC casing, should be placed into the cement grout. It will be fitted with a hinged cap with a lock.

(e) Survey of Wells. Each well will be located with reference to vertical and horizontal control by survey methods.

(f) Well Development. Each well will be fully developed as soon as practical after installation, but no sooner than 48 hours following the placement of cement grout. Development will be accomplished with a pump or bottom discharge bailer, supplemented with a surge block until the water removed from the well is clear. At a minimum, each well will be pumped or bailed for 2 hours as part of the development. The development equipment will be washed with clean water before each use to prevent cross contamination from one well to another.

(g) Sampling, Analysis, and Data Evaluation. Phase 2 sampling, analysis, and data evaluation will be conducted as described in paragraph 5d(1), this report, and Appendix F. This will include all monitoring wells around the DDT Hazardous Waste Landfill and the Sanitary Landfill. The rate of ground-water movement will be determined from soils laboratory permeability and porosity values and the ground-water gradient.

(h) Contigency Plan. Phase 2 will be expanded to totally define any plume of ground-water contamination caused by the DDT Hazardous Waste Landfill. This contingency is based on detection of a concentration of DDT considered significant by the State of Alabama in the downgradient monitoring wells.

6. ADDITIONAL INFORMATION.

a. The ground-water quality assessment plan described in this report will be implemented by this Agency, upon written request.

b. The approximate schedule of work will be coordinated with the State by Redstone Arsenal and this Agency.

for WAYNE A. FOX
Geologist
Waste Disposal Engineering Division

APPROVED:

FREDERICK W. BOECHER
MAJ(P), MSC
Chief, Waste Disposal Engineering Division

APPENDIX A

REFERENCES

1. Alabama Department of Public Health, Hazardous Waste Management Regulations, promulgated pursant to Act 129 of 1978, effective 19 November 1980, revisions effective 19 July 1982.

2. Environmental Geology and Hydrology, Huntsville and Madison County, Alabama, Geological Survey of Alabama, Atlas Series 8.

3. "Redstone Arsenal (RSA) Installation Restoration Summary," 3 volumes, prepared by Water and Air Research, Inc., Gainesville, Florida for the US Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, March 1983.

4. Letter, DRSMI-KLC, Redstone Arsenal, 26 January 1983, subject: Results of the 1982 Ground-water Monitoring Program at Redstone Arsenal.

5. Letter, DRSMI-KLC, Redstone Arsenal, 14 October 1983, subject: Results of the First Semi-annual Sampling of the Ground-water Monitoring Wells for Redstone Arsenal.

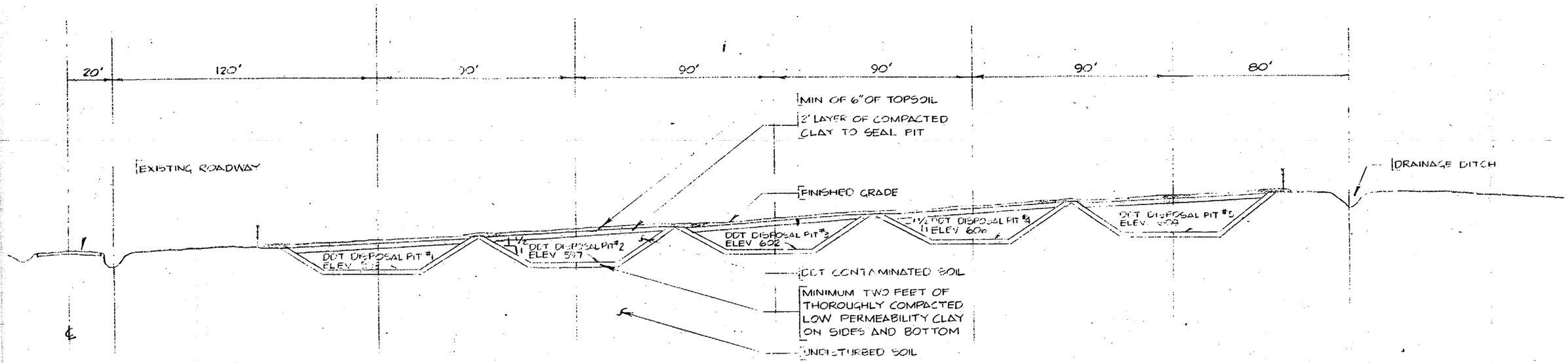
6. "Report of Soils Testing Performed at the DDT Landfill Site, Redstone Arsenal, Alabama," Testing Incorporated, 1978, Contract No. DHCAH03-78-M-2210.

7. "Report of Geohydrology Characterization and Well/Lysimeter Installation at Redstone Arsenal, Alabama," Testing Incorporated, 1979, Contract No. DAAH03-78-C-0180.

8. Letter, Alabama Department of Environmental Management, 20 September 1983, subject: Recommendations for DDT Hazardous Waste Landfill.

APPENDIX B

CONSTRUCTION DETAILS FOR THE DDT HAZARDOUS WASTE LANDFILL



CROSS SECTION
HAZARDOUS WASTE LANDFILL

0 30' 60' 90'

REV	BY	REQUEST NUMBER	DATE	SAFETY	USING SERVICE	FIRE MARSHAL	CHECKER	PROJ ENG	CHIEF ENG

REDSTONE ARSENAL SUPPORT ACTIVITY
REDSTONE ARSENAL
REDSTONE ARSENAL, ALABAMA

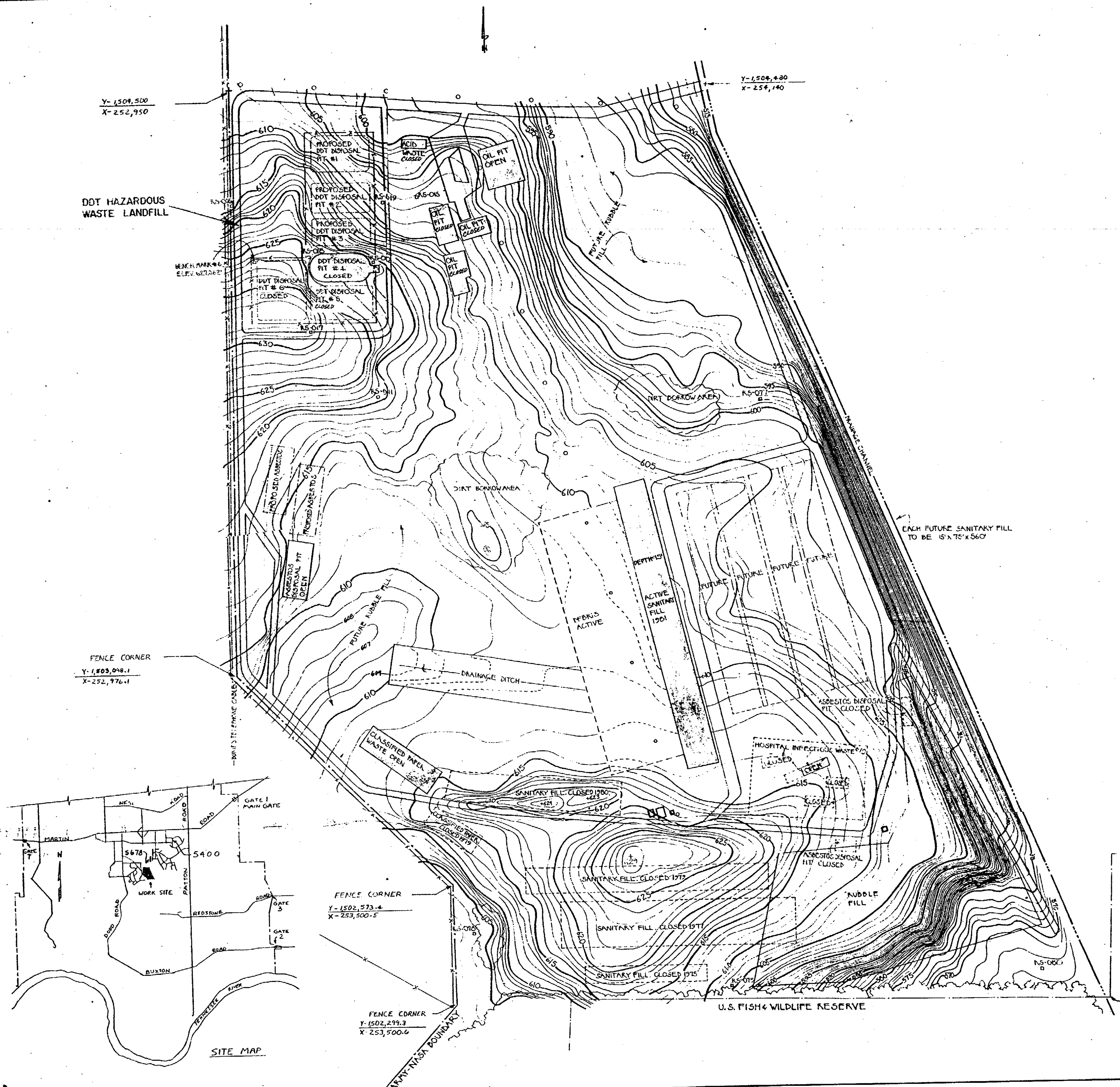
DRAWN: G. MOORE
DESIGNED: J.A.S.
CHECKED: L.M.B.
PROJ. ENG. B J H
FIRE MARSHAL: BLE
SAFETY DIRECTOR:
USING SERVICE:
REQUEST NUMBER: 2166369900

FIGURE B-2.
COLLECTION AND DISPOSAL OF DDT CONTAMINATED MATERIALS

William J Hood
CHIEF ENGINEER

SCALE: NOTED
DATE: 29 NOV 1978
DRAWING NUMBER: 4942
SHEET NUMBER: 6

Ground-water Quality Assessment Plan No. 38-26-0441-84, 26-29 Sep 83



TEST WELLS

WELL NO.	DEPTH OF WELL	DEPTH TO WATER	ELEV.
RS-010	74.2'	45.5'	617.94'
RS-011	60.9'	17.8'	622.08'
RS-015	66.4'	15.0'	606.27'
RS-016	55.0'	25.8'	616.86'
RS-017	50.0'	31.0'	633.06'
RS 018	46.0'	28.0'	627.28'
RS-019	30.0'	17.5'	608.16'
RS-077	37.8'	19.95'	597.44'
RS-078	34.0'	15.06'	594.97'
RS-079	54.9'	37.74'	605.63'
RS-080	29.0'	7.45'	567.29'

LEGEND

- FENCE
- PROPERTY LINE
- ROAD
- OLD DUMPS
- PROPOSED DUMPS
- EXISTING DUMPS
- CONTOURS
- BUILDINGS
- UTILITY POLES
- RS-015 TEST WELLS

0 100' 150' 200'

FIGURE 1.

REDSTONE ARSENAL SUPPORT ACTIVITY
REDSTONE ARSENAL
REDSTONE ARSENAL, ALABAMA

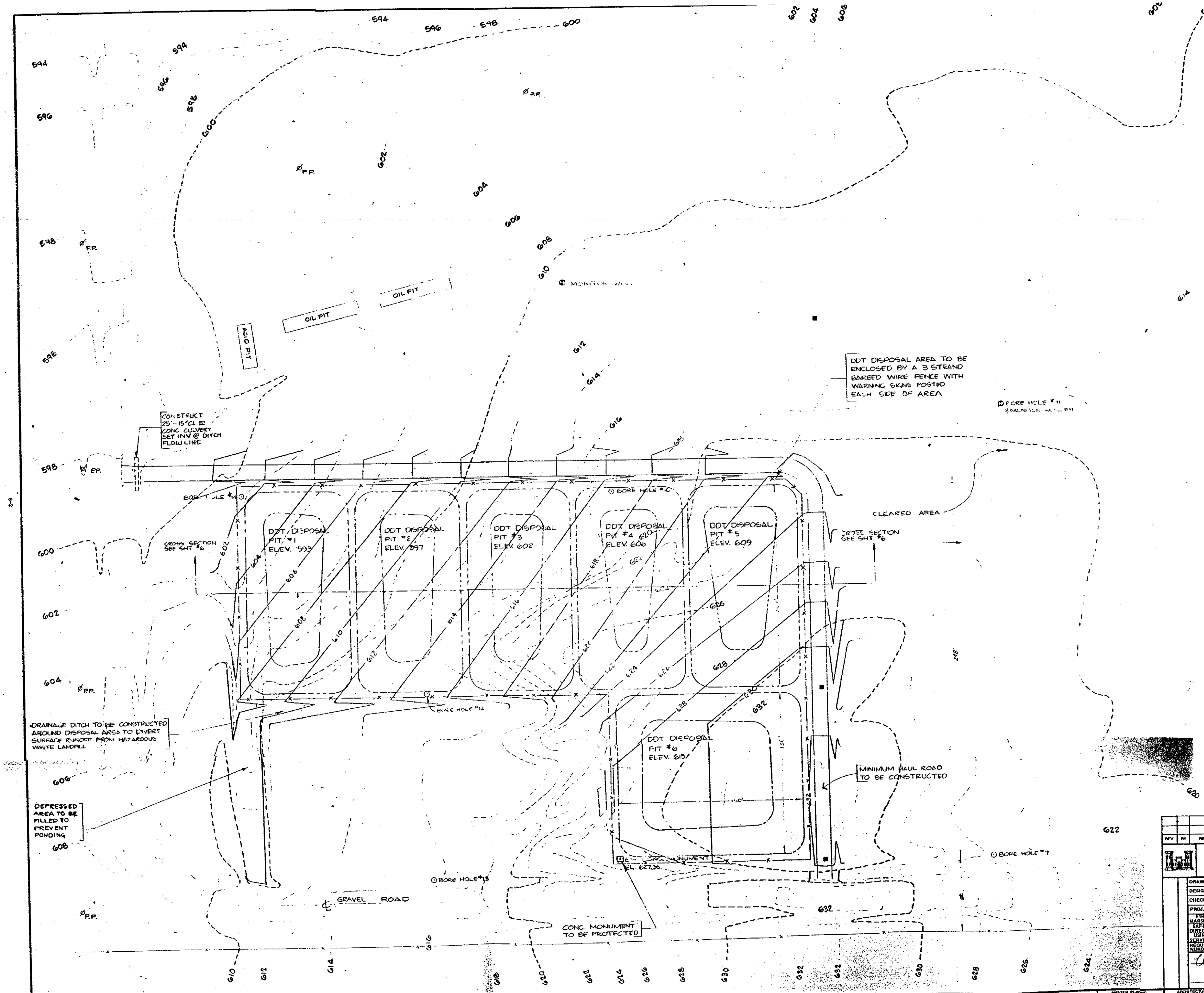
DRAWN:	RJS PATEL
DESIGNED:	ERC
CHECKED:	JS
PROJ. ENG.	BJH
FIRE MARSHAL:	N.R.
SAFETY DIRECTOR:	
USING SERVICE:	
REQUEST NUMBER:	024 JLA 6115

TOPOGRAPHIC MAP OF THE SANITARY FILL AREA

DRAWING NUMBER: 5058

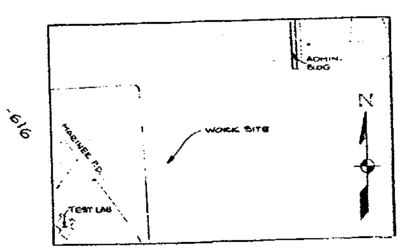
DATE: AUG.-25-81

SHEET NUMBER: 1



GENERAL NOTES:

1. THE CONTRACTOR SHALL CONSTRUCT, AS NECESSARY FOR HAULING AND EQUIPMENT ACCESS, A MINIMUM ROADWAY ADJACENT TO THE DISPOSAL PITS. THE ROADWAY SHALL HAVE 3"-4" OF GRAVEL AND WILL BE LEFT IN PLACE AFTER THE WORK IS COMPLETE.
2. DDT DISPOSAL PITS *5 AND 6 ONLY TO BE OPENED UNDER THIS CONTRACT, PITS 1,2,3 AND 4 ARE RESERVED FOR FUTURE USE. DISPOSAL PITS ARE TO BE EXCAVATED TO GRADES SHOWN. THE SIDES AND* BOTTOMS OF THE PITS SHALL CONSIST OF A MINIMUM OF TWO FEET OF NATURAL OR EMPLACED LOW PERMEABILITY CLAY. THE CLAY WILL BE TAKEN FROM THE REMOVED MATERIAL AT THE TEN FOOT DEPTH. THE SIDES AND BOTTOMS OF THE PITS SHALL BE THOROUGHLY COMPACTED TO A PROCTOR DENSITY OF 95%.
3. HAZARDOUS WASTES SHALL BE PLACED IN THE PITS IN ONE FOOT LAYERS. EACH LAYER WILL BE COMPACTED BY A MINIMUM OF SIX PASSES OF A VIBRATING ROLLER
4. TRUCKS OR EARTHMOVING EQUIPMENT USED TO HANDLE THE UNCONTAMINATED SOIL WILL NOT BE THE SAME ONES USED TO HANDLE CONTAMINATED MATERIAL
5. AT THE END OF EACH DAY, AND AS DIRECTED BY THE CONTRACTING OFFICER, THE CONTAMINATED SOIL SHALL BE COVERED WITH AN IMPERVIOUS PLASTIC SHEET. AT THE END OF EACH DAY THERE WILL BE NO EXPOSED DDT RESIDUES.
6. AS EACH DDT PIT IS FILLED, THE TOP WILL BE SEALED WITH TWO FEET OF COMPACTED CLAY ALL OF THE DISPOSAL AREA WILL BE COVERED WITH SIX INCHES OF TOPSOIL, FERTILIZED, SEEDED AND MULCHED



VICINITY MAP

0 800' 1600' 2400'

REV	BY	REQUEST NUMBER	DATE	SAFETY	USING SERVICE	FIRE MARSHAL	CHECKER	PROJ ENG	CHIEF ENG

REDSTONE ARSENAL SUPPORT ACTIVITY
REDSTONE ARSENAL
REDSTONE ARSENAL, ALABAMA

DRAWN:	G MOORE
DESIGNED:	J A S
CHECKED:	L M B
PROJ. ENG.	B J H
FIRE MARSHAL:	BLE
SAFETY DIRECTOR:	FAE
USING SERVICE:	[signature]
REQUEST NUMBER:	2166369900

FIGURE B-1.
COLLECTION AND DISPOSAL OF DDT CONTAMINATED MATERIALS

William J Hood
CHIEF ENGINEER

DATE 29 NOV. 1978

DRAWING NUMBER 4942

SHEET NUMBER 5

MASTER PLANNING | ARCHITECTURAL | CIVIL | ELECTRICAL | MECHANICAL | STRUCTURAL

APPENDIX C

BORING LOGS FOR MONITORING WELLS LYSIMETERS, AND TEST BORING

(Source: References 6 and 7)

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-7
Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 87.5 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 87.5 Ft.
Depth to Water in Boring @ Drilling 39.5 Ft.
Depth to Water in Boring 72 hrs. 37.7 Ft.
Elevation Ft. 626.5

Date: 8-10-78
Weather: Cloudy & Rain
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
					Topsoil				
				1	Very stiff red silty sandy clay (10R 3/6) (Sandy Clay - USDA)	CL	4.5	8/11-14	15.6
10				2	Same as No. 1 (10R 3/6) (Sandy Clay - USDA)	CL	3.5	3/7-7	20.4
				3	Same as No. 1 (10R 4/6) (Sandy Clay - USDA)	CL	3.75	5/9-9	23.7
20				4	Same as No. 1 (10R 4/8) (Sandy Clay - USDA)	CL	2.75	4/8-16	19.8
				5	Same as No. 1 (10R 4/8) (Sandy Clay - USDA)	CL	2.5	10/15-12	17.1
30				6	Loose Reddish Yellow Sand (medium-grain) (2.5YR 4/8) (Sand - USDA)	SP-SM	*	8/10-17	6.7
				7	Same as No. 6 (2.5YR 4/8) (Sand - USDA)	SP-SM	*	13/15-14	8.9
40					(continued on Page 2)				

REMARKS: * Too much sand for accurate PPR

TESTING INCORPORATED
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-7 (Page 2)
Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 87.5 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 87.5 Ft.
Depth to Water in Boring @ Drilling 39.5 Ft.
Depth to Water in Boring 72 hrs. 37.7 Ft.
Elevation Ft. 626.5

Date: 8-11-78
Weather: Cloudy & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
				8	Loose to medium dense clayey sand (2.5YR 4/8) (Clayey Sand - USDA)	SC	*	23 / 18-11	19.5
				9	Stiff yellow red and gray highly plastic clay with traces of soft stone (7.5YR 5/0) (Clay - USDA)	CH	2.0	5 / 7-7	38.2
50				10	Stiff gray, red and yellow highly plastic clay with soft stone and sand traces (10YR 6/8) (Clay - USDA)	CH	1.75	1 / 4-6	38.9
				11	Same as No. 10 (10YR 6/8) (Clay - USDA)	CH	1.75	4 / 7-7	27.4
60				12	Same as No. 10 (10YR 6/8) (Clay - USDA)	CH	1.75	5 / 7-5	39.4
				13	Same as No. 10 (10YR 6/8) (Clay - USDA)	CH	1.5	4 / 6-6	27.4
70				14	Stiff yellow and brown highly plastic clay with weathered rock and large sand lenses (10YR 5/8) (Clay - USDA)	CH	2.0	5 / 8-6	22.5
				15	Same as No. 14 (10YR 5/8) (Clay - USDA)	CH	1.25	4 / 4-4	34.7
80					(continued on Page 3)				

REMARKS: * Too much sand for accurate PPR

TESTING Incorporated
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-7 (Page 3)
Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg, 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 87.5 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 87.5 Ft.
Depth to Water In Boring @ Drilling 39.5 Ft.
Depth to Water in Boring 72 hrs. 37.7 Ft.
Elevation Ft. 626.5

Date: 8-11-78
Weather: Cloudy & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
80									
		X		16	Same as No. 14 (10YR 5/8) (Clay - USDA)	CH	.75	7 / 9-10	33.1
		X		17	Same as No. 14 (10YR 5/8) (Clay - USDA)	CH	.75	8 / 10-11	37.0
90					Refusal - Probably rock or boulder				
100									
110									
120									

REMARKS: ____

TESTING
P.O BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-8

Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 62.1 ft.
Rock ---------- ft.
Auger ---------- ft.

Completion Depth 62.1 Ft.
Depth to Water in Boring @ Drilling 48.0 Ft.
Depth to Water in Boring 24 hrs. 50* Ft.
Elevation Ft. 626.9

Date: 8-11 & 14-78
Weather: Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
					Topsoil				
		X		1	Very stiff red sandy silty clay (10R 4/6) (Silty Clay - USDA)	CL	4.0	4/8-11	23.7
10		X		2	Same as No. 1 (10R 4/8) (Silty Clay)	CL	4.0	7/9-10	19.7
		X		3	Very stiff yellow & red silty sandy clay (2.5YR 4/8) (Sandy Clay)	SC	4.5	4/7-10	20.4
20		X		4	Very stiff gray, brown and yellow medium plastic clay with soft stone (7.5YR 6/8) (Clay - USDA)	CL	4.0	4/7-8	35.6
		X		5	Very stiff yellowish brown medium plastic to highly plastic clay with large amounts of sand and soft stone (7.5YR 5/6) (Clay - USDA)	CH	4.5	5/10-16	21.1
30		X		6	Same as No. 5 (7.5YR 5/6) (Clay - USDA)	CH	3.75	4/7-9	29.2
		X		7	Same as No. 5 (7.5YR 5/6) (Clay - USDA)	CH	3.0	5/9-11	29.6
40					(continued on Page 2)				

REMARKS: * Boring was closed at 12'. Closed region was penetrated and a water surface was detected at approximately 50'.

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-8 (Page 2)
Job No. • 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 62.1 ft.
Rock ---- ft.
Auger ---- ft.

Completion Depth 62.1 Ft.
Depth to Water In Boring @ Drilling 48.0 Ft.
Depth to Water in Boring 24 hrs. 50'* Ft.
Elevation Ft. 626.9

Date: 8-14-78
Weather: Clear & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
				8	Same as No. 5 (7.5YR 5/6) (Clay - USDA)	CH	2.75	4 / 5-9	34.7
				9	Very stiff yellowish brown highly plastic clay with weathered rock (5YR 5/6) (Clay - USDA)	CH	2.5	3 / 11-9	42.7
50				10	Same as No. 9 (5YR 5/6) (Clay - USDA)	CH	0.5	6 / 6-8	42.7
				11	Very stiff brown highly plastic clay with sand and weathered rock (5YR 4/6) (Clay - USDA)	CH	2.0	5 / 9-9	26.4
60				12	Very stiff brown highly plastic clay with sand and dense layers of weathered rock (5YR 4/6) (Clay - USDA)	CH	0.75	12 / 12-5	27.5
					Refusal - Probably rock or boulder				
70									
80									

REMARKS: * Boring was closed at 12'. Closed region was penetrated and a water surface was located at approximately 50'

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-9
Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 69.7 ft.
Rock ---- ft.
Auger ---- ft.

Completion Depth 69.7 Ft.
Depth to Water in Boring @ Drilling 69.7 Ft.
Depth to Water in Boring 120 hrs. 56.8 Ft.
Elevation Ft. 631.7

Date: 8-08 & 09-78
Weather: Cloudy & Humid
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
					Topsoil, silt & organic material				
				1	Stiff red sandy silty clay (10R 3/6) (Silty Clay - USDA)	CL	2.5	5/6-8	26.1
10				2	Same as No. 1 (10R 3/6) (Silty Clay - USDA)	CL	3.25	5/9-12	20.6
				3	Very stiff yellowish red silty sandy clay (2.5YR 4/7) (Sandy Clay - USDA)	CL	4.5+	6/13-18	16.7
20				4	Very stiff gray, yellow & brownish red highly plastic clay w/sand lenses & soft stone (5YR 5/6) (Clay - USDA)	CH	4.5+	5/8-12	25.7
				5	Very stiff reddish yellow highly plastic clay with dense chert (7.5YR 5/6) (Clay - USDA)	CH	4.25	10/11-13	22.2
30				6	Very stiff reddish yellow highly plastic clay with dense weathered chert (10YR 5/6) (Clay - USDA)	CH	3.25	23/24-12	23.4
				7	Very stiff yellowish brown highly plastic clay with weathered chert, black ore traces, and sand lenses (7.5YR 5/8) (Clay - USDA)	CH	3.25	3/8-9	26.3
40									

(continued on Page 2)

REMARKS:

TESTING Incorporated
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-9 (Page 2)

Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 69.7 ft.
Rock ---------- ft.
Auger ---------- ft.

Completion Depth 69.7 Ft.
Depth to Water in Boring @ Drilling 69.7 Ft.
Depth to Water in Boring 120 hrs. 56.8 Ft.
Elevation Ft. 631.7

Date: 8-09-78
Weather: Partly Cloudy & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
		X		8	Very stiff yellowish brown highly plastic clay with black ore traces & sand lenses (5YR 5/6) (Clay - USDA)	CH	2.5	11 / 7-10	36.3
		X		9	Very stiff brown highly plastic clay with sand lenses and weathered chert (7.5YR 5/6) (Clay - USDA)	CH	2.5	4 / 7-10	25.2
50		X		10	Very stiff yellowish brown highly plastic clay with black ore traces, sand lenses and weathered rock (5YR 5/8) (Clay - USDA)	CH	2.5	6 / 5-7	39.4
		X		11	Same as No. 10 (5YR 5/6) (Clay - USDA)	CH	2.0	5 / 5-6	34.6
60		X		12	Same as No. 10 (5YR 5/6) (Clay - USDA)	CH	1.5	5 / 6-7	36.0
		X		13	Same as No. 10 (5YR 5/6) (Clay - USDA)	CH	0.75	9 / 19-12	20.4
70					Refusal - Probably rock or boulder				
80									

REMARKS:

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-10
Job No. 78-45

CLIENT: P&C, Proc Div For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 74.2 ft.
Rock ft.
Auger ft.

Completion Depth 74.2 Ft.
Depth to Water in Boring @ Drilling 1 hr-59.0 Ft.
Depth to Water in Boring 144 hrs. 46.6 Ft.
Elevation Ft. 617.8

Date: 8-07-78
Weather: Clear & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
					Topsoil and silt				
		X		1	Stiff red sandy silty clay (2.5YR 3/6) (Silty Clay - USDA)	CL	3.0	4/5-5	18.7
10		X		2	Same as No. 1 (2.5YR 3/6) (Silty Clay - USDA)	CL	3.5	5/6-7	20.7
		X		3	Same as No. 1 (2.5 YR 3/6) (Silty Clay - USDA)	CL	2.75	4/7-7	24.7
20		X		4	Very stiff yellow red sandy clay (2.5YR 3/6) (Sandy Clay - USDA)	CL	3.5	6/8-10	19.7
		X		5	Same as No. 4 (2.5YR 3/6) (Sandy Clay - USDA)	CL	2.0	5/6-8	17.1
30		X		6	Very stiff gray and red highly plastic clay with layers of sand and soft stone traces (2.5YR 6/4) (Clay - USDA)	CH	2.5	4/7-14	36.0
		X		7	Very stiff gray, red & yellow highly plastic clay with layers of sand, soft stone traces and chert (2.5YR 4/8) (Clay - USDA)	CH	3.0	6/8-12	29.5
40					(continued on page 2)				

REMARKS:

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-10 (Page 2)
Job No. 78-45

CLIENT: P&C, Proc Div For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 74.2 ft.
Jack ____ ft.
Auger ____ ft.

Completion Depth 74.2 Ft.
Depth to Water in Boring @ Drilling 1 hr-59.0 Ft.
Depth to Water in Boring 144 hrs. 46.6 Ft.
Elevation Ft. 617.8

Date: 8-07 & 08-78
Weather: Clear & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
		X		8	Same as No. 7 (2.5YR 5/8) (Clay - USDA)	CH	3.5	6 / 13-18	20.7
		X		9	Very stiff brownish yellow highly plastic clay with weathered chert (5YR 5/8) (Clay - USDA)	CH	3.0	5 / 8-10	28.2
50		X		10	Very stiff yellow cherty clay (weathered) (7.5YR 5/8) (Clay - USDA)	CH	*	5 / 11-12	30.0
		X		11	Very stiff reddish yellow highly plastic clay with weathered chert and sand (2.5YR 5/6) (Clay - USDA)	CH	2.5	4 / 8-8	27.6
60		X		12	Very stiff yellow brown sandy highly plastic clay with chert (5YR 4/6) (Clay - USDA)	CH	*	4 / 8-12	29.7
		X		13	Same as No. 12 (5YR 4/6) (Clay - USDA)	CH	*	8 / 19-15	32.0
70		X		14	Soft yellow brown sandy highly plastic clay with chert (5YR 4/6) (Clay - USDA)	CH	0.75	0 / 5-3	44.0
					Refusal - Probably rock or boulder				
80									

REMARKS:

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-11
Job No. 78-45

CLIENT: P&C, Proc Div For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 60.9 ft.
Auger ft.
Vibracore ft.

Completion Depth 60.9 Ft.
Depth to Water in Boring @ Completion-51.0 Ft.
Depth to Water in Boring 96 hrs. 25.0 Ft.
Elevation Ft. 621.7

Date: 8-09 & 10-78
Weather: Partly Cloudy & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
				1	Very stiff red silty sandy clay (2.5YR 3/6) (Sandy Clay - USDA)	CL	4.0	6 / 8-9	18.1
10				2	Loose yellow clayey sand (2.5YR 4/8) (Clayey Sand - USDA)	SC	2.0	8 / 7-7	12.9
				3	Stiff yellow silty sand (7.5YR 6/8) (Loamy Sand - USDA)	SM	*	7 / 6-7	14.3
20				4	Very stiff medium plastic clay with sand lenses and soft stone traces (10YR 6/8) (Clay - USDA)	CL-CH	4.0	5 / 10-10	24.9
				5	Same as No. 4 (10YR 6/8) (Clay - USDA)	CL-CH	4.5	6 / 8-10	19.1
30				6	Very stiff brown highly plastic clay with dense chert with sand (7.5YR 5/6) (Clay - USDA)	CH	*	17 / 14-15	24.2
				7	Very stiff brown highly plastic clay with dense chert with large sand lenses (7.5YR 5/8) (Clay - USDA)	CH	2.25	4 / 6-7	26.0
40					(continued on Page 2)				

REMARKS: * Too much sand or chert for PPR

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-11 (Page 2)
Job No. 78-45

CLIENT: P&C, Proc Div For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 60.9 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 60.9 Ft.
Depth to Water in Boring @Completion 51.0 Ft.
Depth to Water in Boring 96 hrs. 25.0 Ft.
Elevation Ft. 621.7

Date: 8-09-78
Weather: Partly Cloudy & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
				8	Same as No. 7 (7.5YR 5/8) (Clay - USDA)	CH	2.75	3/6-9	29.7
				9	Brown sandy clay with weathered chert (7.5YR 5/8) (Sandy Clay - USDA)	CL	1.0	5/10-10	25.0
50				10	Brown sandy clay with dense weathered chert (7.5YR 5/8) (Sandy Clay - USDA)	CL	0.75	10/10-12	25.1
				11	Very stiff brown cherty clay plus weathered rock (7.5YR 4/6) (Clay - USDA)	CH	*	7/12-22	26.2
60				12	Same as No. 11 (7.5YR 4/6) (Clay - USDA)	CH	*	19/25-50	30.2
					Refusal - Probably rock or boulder				
70									
80									

REMARKS: * Too much chert for PPR

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-12

Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING
Standard 49.8 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 49.8 Ft.
Depth to Water in Boring @ Drilling 35.0 Ft.
Depth to Water in Boring 72 hrs. 28.0 Ft.
Elevation Ft. ____

Date: 9-29-78
Weather: Clear & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
					Topsoil with red sandy silty clay				
				1	Very stiff dark red silty sandy clay (2.5YR 3/6) (Sandy Clay - USDA)	CL	2.5	4 7-8	22.5
10				2	Very stiff yellow and brown sandy clay (5YR 5/8) (Sandy Clay - USDA)	CL	4.5	6 7-11	22.9
				3	Same as No. 2 (5YR 5/8) (Sandy Clay - USDA)	CL	4.5	7 12-14	24.4
20				4	Very stiff gray, yellow and brown highly plastic clay w/sand & weathered soft stone (2.5R 5/6) (Clay - USDA)	CH	4.0	5 10-10	28.4
				5	Very stiff brown highly plastic clay with dense chert (5YR 5/8) (Clay - USDA)	CH	3.25	11 37-12**	40.1
30				6	Very stiff yellow and brown cherty clay (5YR 5/8) (Clay - USDA)	CH	*	14 13-17	24.2
				7	Same as No. 6 (5YR 5/8) (Clay - USDA)	CH	2.0	5 7-8	37.6
40					(continued on Page 2)				

REMARKS: * Too much chert for PPR. Note: Shelby tube at 30' damaged in dense materia

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-12 (Page 2)
Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING
Standard 49.8 ft.
Rock ----- ft.
Auger ft.

Completion Depth 49.8 Ft.
Depth to Water in Boring @ Drilling 35.0 Ft.
Depth to Water in Boring 72 hrs. 28.0 Ft.
Elevation Ft.

Date: 9-29-78
Weather: Clear & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
		X		8	Very stiff yellow and brown cherty clay (5YR 5/6) (Clay - USDA)	CH	1.5	6/7-8	27.9
		X		9	Same as No. 8 (5YR 5/6) (Clay USDA)	CH	*	4/13-11	42.7
50					Auger Refusal				
60									
70									
80									

REMARKS: * Too much chert for PPR.

TESTING INCORPORATED
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-13

Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING
Standard 49.9 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 49.9 Ft.
Depth to Water in Boring @ Completion-41.0 Ft.
Depth to Water in Boring ____ hrs. ____ Ft.
Elevation Ft. ____

Date: 10-03-78
Weather: Clear & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
					Topsoil				
				1	Stiff red sandy silty clay (10R 4/8) (Silty Clay - USDA)	CL	2.0	4/5-6	23.0
10				2	Very stiff yellowish red silty sandy clay with soft stone (2.5YR 4/8) (Sandy Clay - USDA)	CL	4.5	6/7-8	18.3
				3	Very stiff reddish yellow silty sandy clay with red sandy lenses (7.5YR 5/8) (Sandy Clay - USDA)	CL	4.25	6/8-11	21.7
20				4	Stiff yellow medium plastic clay with sand and chert (7.5YR 5/8) (Sandy Clay - USDA)	CL	4.0	4/5-6	36.1
				5	Very stiff brown cherty clay (2.5YR 5/8) (Clay - USDA)	CH	*	6/10-10	40.4
30				6	Very stiff brown highly plastic clay with sand and dense chert (5YR 5/6) (Clay - USDA)	CH	2.25	13/9-8	33.3
				7	Stiff brown highly plastic clay with dense sand lenses and traces of chert (5YR 4/4) (Clay - USDA)	CH	1.75	4/5-8	30.5
40					(continued on Page 2)				

REMARKS: * Too much chert for accurate PPR.

TESTING INCORPORATED
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-13 (Page 2)
Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING
Standard 49.9 ft.
Rock ---------- ft.
Auger ---------- ft.

Completion Depth 49.9 Ft.
Depth to Water In Boring @ Completion- 41.0 Ft.
Depth to Water in Boring ---- hrs. ---- Ft.
Elevation Ft. ----

Date: 10-03-78
Weather: Clear & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
				8	Very stiff brown highly plastic clay with weathered rock and sand (2.5YR 4/6) (Clay - USDA)	CH	1.75	6 9-7	26.1
				9	Same as No. 8 (2.5YR 4/6) (Clay - USDA)	CH	2.0	5 10-6	28.8
50					Refusal - probably rock or boulder				
60									
70									
80									

REMARKS: ----

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-14
Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING
Standard 51.0 ft.
Rock ---- ft.
Auger ---- ft.

Completion Depth 51.0 Ft.
Depth to Water in Boring @ Drilling 42.3 Ft.
Depth to Water in Boring 24 hrs. 41.5 Ft.
Elevation Ft. ----

Date: 10-02-78
Weather: Clear & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	F Unified Soil Classification	PPR	N	W
					Topsoil				
		X		1	Stiff brown silty clay (7.5YR 4/4) (Silty Clay - USDA)	CL	1.0	3/4-4	22.5
10		X		2	Stiff reddish brown silty clay (5.0YR 4/6) (Silty Clay - USDA)	CL	1.0	4/4-6	20.3
		X		3	Firm dark red silty clay (2.5YR 3/6) (Silty Clay - USDA)	CL	1.5	3/3-4	20.6
20		X		4	Firm red silty sandy clay (2.5YR 4/6) (Sandy Clay - USDA)	CL	1.25	2/2-3	22.5
		X		5	Same as No. 4 (2.5YR 4/6) (Sandy Clay - USDA)	CL	2.0	4/4-6	19.7
30		X		6	Stiff yellow and brown highly plastic clay with dense chert (2.5YR 4/8) (Sandy Clay - USDA)	MH	*	3/6-5	44.3
		X		7	Very stiff yellowish red silty cherty clay (5.0YR 5/8) (Sandy Clay - USDA)	MH	*	4/10-10	32.9
40					(continued on Page 2)				

REMARKS: * Too much chert for PPR.

TESTING
P O BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-14 (Page 1)
Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL
BORING LOCATION: See Boring Print

TYPE OF DRILLING
Standard 51.0 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 51.0 Ft.
Depth to Water in Boring @ Drilling 42.3 Ft.
Depth to Water in Boring 24 hrs. 41.5 Ft.
Elevation Ft. ____

Date: 10-02-78
Weather: Clear & Hot
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
		X		8	Stiff reddish brown sandy clay with dense chert (2.5YR 4/6) (Sandy Clay - USDA)	MH	1.0	5 6-7	21.4
		X		9	Same as No. 8 (2.5YR 4/6) (Sandy Clay - USDA)	MH	0.5	4 5-3	30.7
50		X		10	Firm brown sandy clay with dense chert (2.5YR 4/8) (Sandy Clay - USDA)	MH	0.5	2 3-4	26.7
					Boring Terminated				
60									
70									
80									

REMARKS:

TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-015

Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 66.4 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 66.4 Ft.
Depth to Water In Boring @ Drilling 65.0 Ft.
Depth to Water in Boring 24 hrs. 27.0 Ft.
Elevation Ft. ____

Date: 11-14 & 15-78
Weather: Cloudy & Warm
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
					Topsoil and sandy silt				
		X		1	Stiff drak red silty sandy clay (10R 3/6) (Sandy Clay - USDA)	CL	4.0	5 / 6-7	18.0
10		X		2	Same as No. 1	CL	2.5	5 / 3-5	17.4
		X		3	Same as No. 1	CL	2.5	5 / 7-7	23.4
20		X		4	Same as No. 1	CL	2.5	5 / 7-10	16.8
		X		5	Very stiff yellow and red medium plastic sandy clay (2.5YR 4/8) (Sandy Clay - USDA)	CL	3.75	7 / 10-13	32.1
30		X		6	Stiff yellow and red medium plastic sandy clay (2.5YR 4/8) (Sandy Clay - USDA)	CL	3.75	6 / 7-7	48.5
		X		7	Stiff yellow and red medium plastic sandy clay with sand lenses (2.5YR 4/8) (Sandy Clay - USDA)	CL	2.75	5 / 6-8	30.6
40					(continued on page 2)				

REMARKS: ____

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-015 (Page
Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 66.4 ft.
Rock ----- ft.
Auger ft.

Completion Depth 66.4 Ft.
Depth to Water in Boring @ Drilling 65.0 Ft.
Depth to Water in Boring 24 hrs. 27.0 Ft.
Elevation Ft.

Date: 11-14 & 15-78
Weather: Cloudy & Warm
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	z	w
		☒		8	Stiff yellow and red medium plastic sandy clay with sand lenses and soft stone (2.5YR 4/8) (Sandy Clay - USDA)	CL	3.25	5/10-8	31.4
		☒		9	Same as No. 8	CL	2.0	6/6-8	57.5
50		☒		10	Same as No. 8	CL	2.25	4/5-7	30.9
		☒		11	Same as No. 8	CL	2.5	4/8-7	22.1
60		☒		12	Same as No. 8	CL	1.5	3/6-7	33.8
		☒		13	Stiff brown highly plastic clay with sand and weathered rock (7.5YR 4/6) (Clay - USDA)	CH	0.5	7/8-10	22.5
					Refusal - Probably rock or boulder				
70									
80									

REMARKS:

TESTING
P O BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-016
Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 55.0 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 55.0 Ft.
Depth to Water in Boring @ Drilling 50.0 Ft.
Depth to Water in Boring ____ hrs. ____ Ft.
Elevation Ft. ____

Date: 11-15-78
Weather: Cloudy & Warm
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
					Topsoil, silt and red silty sandy clay				
		X		1	Stiff red silty sandy clay (10R 4/8) (Sandy Clay - USDA)	CL	2.25	4 / 6-7	25.9
10		X		2	Stiff red silty sandy clay with coarse to medium grained sand lenses	CL	3.75	7 / 12-11	22.2
		X		3	Very stiff yellow and red medium plastic clay with sand and dense soft stone (2.5YR 5/8) (Clay - USDA)	CL	*	5 / 6-9	35.5
20		X		4	Very stiff yellow and brown medium plastic clay with sand and soft stone (5YR 5/6) (Clay - USDA)	CL	4.25	6 / 9-8	25.0
		X		5	Same as No. 4	CL	3.5	5 / 9-10	37.3
30		X		6	Very stiff yellow and brown medium plastic clay with sand, soft stone and chert (5YR 5/6) (Clay - USDA)	CL	*	6 / 8-10	25.4
		X		7	Stiff yellow and brown medium plastic clay with sand, chert and black ore traces	CL	3.0	6 / 6-7	43.6
40					(continued on page 2)				

REMARKS: * Too much chert for PPR

FORM NO. 14

TESTING
P.O BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-016 (Page 1)
Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 55.0 ft.
Rock ---- ft.
Auger ---- ft.

Completion Depth 55.0 Ft.
Depth to Water in Boring @ Drilling 50.0 Ft.
Depth to Water in Boring ---- Ft.
Elevation Ft. ----

Date: 11-15-78
Weather: Cloudy & Warm
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
		X		8	Very stiff red medium plastic clay with sand lenses, chert and layers of gray highly plastic clay (2.5YR 4/6) (Clay - USDA)	CL	2.25	4 6-9	28.7
		X		9	Very stiff brown medium plastic clay with sand and chert (5YR 4/6) (Clay - USDA)	CL	1.5	4 6-8	33.4
50		X		10	Very soft yellow highly plastic clay with chert and possible open voids (5YR 5/8) (Clay - USDA)	CH	*	7 2-0	40.2
					Refusal - Probably rock or boulder				
60									
70									
80									

REMARKS: * Too much chert for PPR

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-017
Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 50.0 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 50.0 Ft.
Depth to Water in Boring @ Drilling ____ Ft.
Depth to Water in Boring ____ hrs. ____ Ft.
Elevation Ft. ____

Date: 12-11-78
Weather: Clear & Cold
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	LYSIMETER INSTALLATION SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
				Topsoil mixed w/red silty sandy clay				
			1	Red Silty Sandy Clay (10R 4/6) (Sandy Clay - USDA)	CL	2.25	4 / 5-6	23.9
10			2	Same as No. 1	CL	4.0	7 / 10-11	19.5
			3	Very stiff yellow and red silty sandy clay (25YR 4/8) (Sandy Clay - USDA)	CL	4.5+	7 / 9-14	22.1
20			4	Very stiff gray, red and yellow medium plastic clay w/sand lenses and dense soft stone (5YR 5/8) (Clay - USDA)	CL	4.5+	9 / 14-19	17.8
			5	Very stiff gray, red and yellow medium plastic clay w/sand lenses and soft stone (5YR 5/8) (Clay - USDA)	CL	3.5	7 / 9-12	27.3
30			6	Same as No. 5		2.5	5 / 11-11	28.8
			7	Very stiff gray, red and yellow medium plastic clay w/black ore traces (5YR 5/6) (Clay - USDA)	CL	3.0	8 / 11-15	24.7
40				(continued on page 2)				

REMARKS: ____

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-017 (Page 2)
Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 50.0 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 50.0 Ft.
Depth to Water in Boring @ Drilling ____ Ft.
Depth to Water in Boring ____ hrs. ____ Ft.
Elevation Ft. ____

Date: 12-12-78
Weather: Sunny & Mild
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	LYSIMETER INSTALLATION	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
40				8	Very stiff gray, red and yellow medium plastic clay w/thick sand lenses and soft stone traces (Clay - USDA)	CL	2.5	6 10-11	26.6
				9	Same as No. 8	CL	3.0	7 8-13	20.8
50					Boring Terminated				
60									
70									
80									

REMARKS: ____

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-018
Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 46.0 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 46.0 Ft.
Depth to Water in Boring @ Drilling ____ Ft.
Depth to Water in Boring ____ hrs. ____ Ft.
Elevation Ft. ____

Date: 12-11-78
Weather: Clear & Cold
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	LYSIMETER INSTALLATION SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
				Mixture of topsoil & red sandy silty clay				
			1	Very stiff red sandy silty clay (10R 4/6) (Silty Clay - USDA)	CL	2.25	6/7-9	24.0
10			2	Same as No. 1	CL	2.5	7/12-15	23.5
			3	Very stiff yellowish red clay w/sand (10R 4/8) (Sandy Clay - USDA)	SC	2.5	10/11-11	13.0
20			4	Same as No. 3	SC	2.5	7/7-11	15.0
			5	Very stiff yellowish red clay w/soft sand stone (10R 4/8) Sandy Clay - USDA)	SC	3.5	8/10-10	16.9
30			6	Very stiff gray, yellow and red medium plastic clay w/dense sand (2.5YR 4/8) (Clay - USDA)	CL	3.5	6/8-9	24.1
			7	Very stiff gray, yellow and red medium plastic clay w/soft stone (2.5YR 4/8) (Clay - USDA)	CL	4.0	5/8-9	20.7
40				(continued on page 2)				

REMARKS: ____

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-018 (Page 2)
Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 46.0 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 46.0 Ft.
Depth to Water in Boring @ Drilling ____ Ft.
Depth to Water in Boring ____ hrs. ____ Ft.
Elevation Ft. ____

Date: 12-11-78
Weather: Clear & Cold
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	LYSIMETER INSTALLATION	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
40				8	Very stiff gray, yellow and red medium plastic clay w/sand lenses (Clay - USDA) (2.5YR 4/8) (Clay - USDA)	CL	3.5	6 9-10	20.6
				9	Same as No. 8	CL	1.0	6 8-8	25.1
					Boring Terminated				
50									
60									
70									
80									

REMARKS: ____

TESTING
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-019
Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prbd, Bldg. 4488, Redstone Arsenal, AL 35809
PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL
BORING LOCATION: See Boring Sketch

TYPE OF DRILLING
Standard 30.0 ft.
Rock ____ ft.
Auger ____ ft.

Completion Depth 30.0 Ft.
Depth to Water in Boring @ Drilling ____ Ft.
Depth to Water in Boring 4 hrs. 26.0 Ft.
Elevation Ft. ____

Date: 11-16-78
Weather: Partly Cloudy & Mild
Driller: B. Butler

DEPTH FT.	SYMBOL	SAMPLES	LYSIMETER INSTALLATION	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	N	W
				1	Stiff red silty sandy clay (2.5YR 3/6) (Sandy Clay - USDA)	CL	3.0	4/5-7	20.7
10				2	Same as No. 1	CL	2.5	4/5-7	22.0
				3	Same as No. 1	CL	2.5	4/6-9	20.6
20				4	Same as No. 1	CL	2.5	4/7-8	20.9
				5	Very stiff red medium plastic clay w/sand and soft stone (2.5YR 4/6) (Clay - USDA)	CL	4.25	6/9-12	35.9
30					Boring Terminated				
40									

REMARKS: ____

APPENDIX D

SOIL ANALYSES

TESTING INCORPORATED
P. O. BOX 1087 1736 5TH AVENUE S E DECATUR, ALABAMA 35601 PHONE: 205 - 353-2911

TABLE NO. 1

REPORT OF SOIL ANALYSIS

CLIENT P&C BR, Proc Div, Dir for Proc & Prod, Redstone Arsenal, AL 35809

JOB PROJECT DDT Landfill Site, Redstone Arsenal, AL

SAMPLE FROM

SOURCE OF MATERIAL

SAMPLE LOCATION:	Boring No. RS-7	Boring No. RS-8	Boring No. RS-8	Boring No. RS-9	Boring No. RS-9	Boring No. RS-10
	Sample No. ST-5	Sample No. ST-6	Sample No. ST-7	Sample No. ST-1	Sample No. ST-2	Sample No. ST-8
Dept. Ft	29.5 - 30.5	14.0 - 16.5	29.0 - 31.0	14.5 - 16.0	29.5 - 30.5	29.5 - 31.5
Unconfined Compressive Strength, P.S.F.						
Vane Shear Strength, P.S.F.						
Unit Weight, Wet, Lbs. Per Cu. Ft.	*	117.7	131.8	130.7	**	121.2
Unit Weight, Dry, Lbs. Per Cu. Ft.	*	99.3	109.9	114.7	**	97.0
Moisture Content, Percent	11.5	18.5	19.9	14.0	**	24.9
Specific Gravity						
Solid Volume Weight Lbs. Per Cu. Ft.						
Liquid Limit	NP	46	36	81	51	64
Plastic Limit	NP	32	19	37	22	29
Plasticity Index	NP	14	17	44	29	35
Classification	SP-SM	SC	SC	CH	CH	CH
PERMEABILITY k (cm/sec)	*	$2x10^{-6}$	$1x10^{-7}$	$3x10^{-8}$	**	$3x10^{-7}$

REMARKS:
* Sample too sandy to hold together for undisturbed testing
** Too little recovery for testing.
NP Non-plastic (Atterberg limits not measureable)

JOB No. 78-45

TESTING INCORPORATED
P. O. BOX 1087 1736 9TH AVENUE S.E. DECATUR, ALABAMA 35601 PHONE: 205 - 353-291

TABLE NO. 1 (cont'd)

REPORT OF SOIL ANALYSIS

CLIENT P&C BR, Proc Div, Dir For Proc & Prod, Redstone Arsenal, AL 35809

JOB PROJECT DDT Landfill Site, Redstone Arsenal, AL

SAMPLE FROM

SOURCE OF MATERIAL

SAMPLE LOCATION:	Boring No. RS-11 Sample No. ST-3 Dept. Ft 14.0 - 16.5	Boring No. RS-11 Sample No. ST-4 27.0 - 29.5	Boring No. RS-12 Sample No. ST-9 15.0-17.5	Boring No. RS-12 Sample No. S-6 30.0-31.0	Boring No. RS-13 Sample No. ST-10 15.0-17.5	Boring No RS-13 Sample No. S-6 30.0-31.0
Unconfined Compressive Strength, P.S.F.						
Vane Shear Strength, P.S.F.						
Unit Weight, Wet, Lbs. Per Cu. Ft.	*	131.7	110.5	---	116.5	---
Unit Weight, Dry, Lbs. Per Cu. Ft.	*	108.9	87.0	---	93.5	---
Moisture Content, Percent	14.3	20.9	27.0	---	24.6	---
Specific Gravity						
Solid Volume Weight Lbs. Per Cu. Ft.						
Liquid Limit	NP	50	53	62	32	71
Plastic Limit	NP	15	27	27	21	36
Plasticity Index	NP	35	26	35	11	35
Classification	SM	CL-CH	CH	CH	CL	MH
PERMEABILITY K (cm/sec)	$2x10^{-4}$	$1x10^{-7}$	$1x10^{-8}$			

REMARKS:

* Sample too sandy to hold together for undisturbed testing

TESTING INCORPORATED
P. O. BOX 1087 1736 5TH AVENUE S E DECATUR, ALABAMA 35601 PHONE: 205 - 353-2911

TABLE NO. 1 (cont'd)

REPORT OF SOIL ANALYSIS

CLIENT P&C, Proc Div, Dir For Proc & Prod, Redstone Arsenal, AL 35809

JOB PROJECT DDT Landfill Site, Redstone Arsenal, AL

SAMPLE FROM

SOURCE OF MATERIAL

SAMPLE LOCATION:	Boring No. RS-14	Boring No.	Boring No.	Boring No.	Boring No.	Boring No
	Sample No. S-6	Sample No.	Sample No.	Sample No.	Sample No.	Sample No
Dept. Ft	30.0-31.0					
Unconfined Compressive Strength, P.S.F.						
Vane Shear Strength, P.S.F.						
Unit Weight, Wet, Lbs. Per Cu. Ft.	--					
Unit Weight, Dry, Lbs. Per Cu. Ft.	--					
Moisture Content, Percent						
Specific Gravity						
Solid Volume Weight Lbs. Per Cu. Ft.						
Liquid Limit	58					
Plastic Limit	34					
Plasticity Index	24					
Classification	MH					

REMARKS:

APPENDIX E

MONITORING WELL AND LYSIMETER CONSTRUCTION DETAILS
(Source: References 6 and 7)

TABLE E-1. MONITORING WELL CONSTRUCTION DETAILS

Well Number	Diameter (inches)	Total Depth (feet)	Depth to Top of Well Screen (feet)	Length of Well Screen (feet)	Depth to Water (feet)
RS010	2	74.2	59.2	10.0	52.86
RS011	2	60.9	45.9	10.0	23.14
RS015	2	66.4	51.0	10.4	22.13
RS016	2	55.0	40.0	10.0	35.34

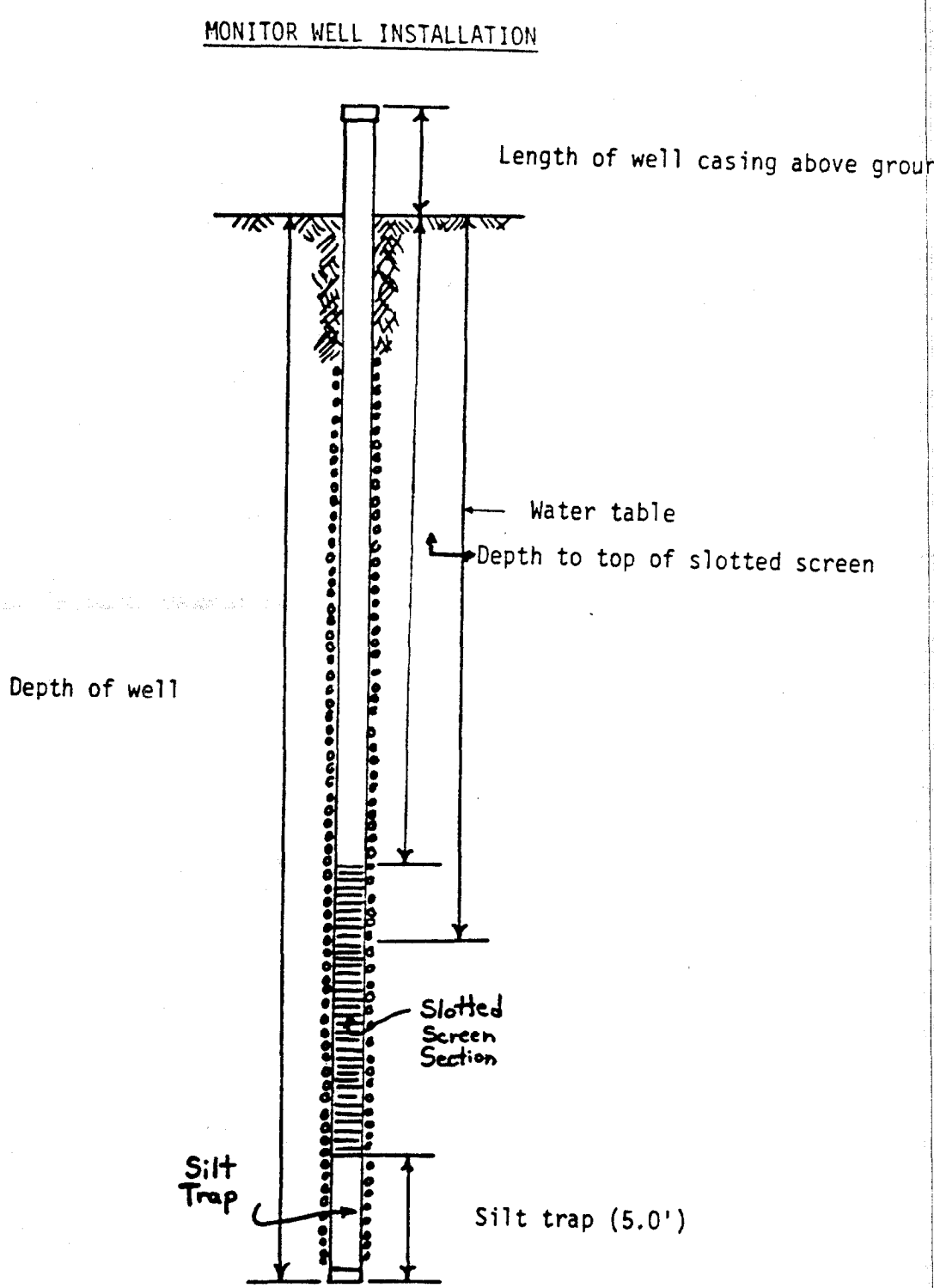
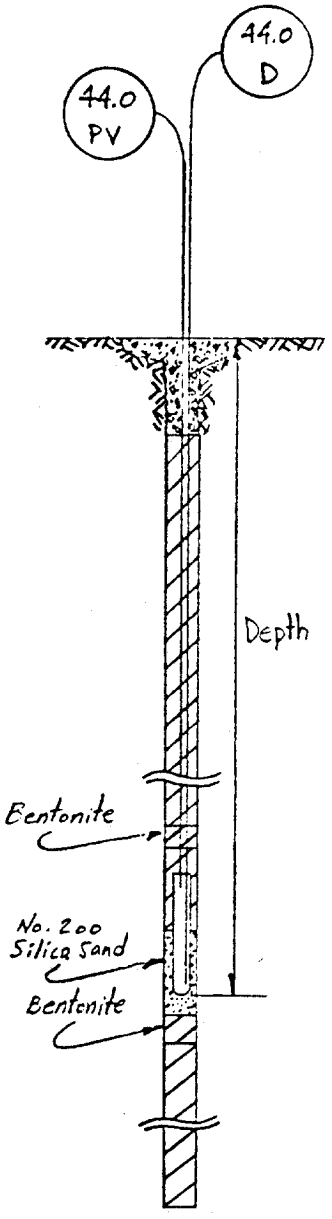


FIGURE E-1. Monitor Well Installation.



Hole No.	Depth (Ft.)
RS-017	16.0
RS-017	31.0
RS-017	44.0
RS-018	17.5
RS-018	28.0
RS-018	39.5
RS-019	17.5
RS-019	24.5

Sample illustation for Lysimeter installed at 44.0' in RS-017
Access tubing marked as labeled:

- 44.0 - Depth of installation
- PV - Pressure Vacuum Tube
- D - Discharge Tube

FIGURE E-2. Lysimeter Installation.

APPENDIX F

INSTRUCTIONS FOR COLLECTION, PREPARATION, AND CHEMICAL ANALYSIS OF GROUND-WATER SAMPLES

1. WELL PURGING. All monitoring wells must be pumped or bailed prior to sampling to ensure that samples are representative of the ground water and do not contain water which has been standing in the casing. For this monitoring program, at least five volumes of water in the well casing should be removed. However, for a low-yield well which does not quickly recharge as it is pumped, the well should be pumped or bailed dry and the sample then obtained as soon as the well recharges. When calculating the amount of water which must be purged, subtract depth to water (from ground surface) from the total depth of the well and then multiply by 0.16 for a 2-inch well, 0.37 for a 3-inch well, or 0.65 for a 4-inch well to obtain the volume of standing water in the well. The amount pumped prior to sampling should be recorded on the field data log sheet. The depth at which the pump should be set when purging a well will depend upon well construction details, water depth in the well, and well recharge rate. For a well which does not recharge as it is pumped, the pump intake should be as deep as possible in the well, but not so deep as to pick up the sediment which has accumulated in the well bottom. In wells which recharge as they are pumped, the pump intake should be about 5 feet below the surface of the water in the well. The pump will have to be lowered if the water level in the well drops during pumping. Pumping in this manner will ensure that the water which has been standing in the well will be efficiently removed and a representative sample taken. When pumping or sampling a well, great care must be exercised to ensure that contaminants are not introduced into the well or a sample. A sampler or sample tubing, or a bailer or bailer cable, must not be allowed to contact the ground or a dirty surface in a vehicle or sampling equipment box. Plastic sheeting may be used for each well sampled. Sampling equipment must be thoroughly cleaned before it is placed in its storage case. In those situations where there is windblown dust at the sampling site, it will be impossible to obtain a good sample. Sampling should be postponed until a more favorable time.

2. SAMPLING.

a. The sample containers should be rinsed several times with a small amount of water pumped from the well prior to filling. All of these containers must be filled to overflowing so that no headspace remains. Samples should be protected from light and kept cool from the time they are collected.

b. Sampling equipment must be thoroughly cleaned between sampling at each well. This may normally be accomplished by rinsing thoroughly with tap water. At least 2 to 3 gallons of water should be pumped through the tubing and pump with each rinsing. If a bailer is used, it should be rinsed three times with tap water and then rinsed three times with distilled water. In those cases where a sampler becomes contaminated by

pumping oily or greasy water, it should be rinsed first with soapy water and then rinsed thoroughly with clean water. It may be necessary to disassemble a pump to effectively clean it of oil and grease. Acetone rinsing is an effective method of removing oil and grease contamination, but should not be used unless it is certain that the materials used to construct the pump or bailer will not be affected.

3. SAMPLE PRESERVATION AND ANALYTICAL METHODS. Samples will be preserved as shown in Table F-1. Analytical methods are listed in Table F-2.

TABLE F-1. PREPARATION OF GROUND-WATER SAMPLES FROM MONITORING WELLS

Parameter Group	Container Size & Type	Field Preparation	Chemical Preservation	Refrigeration at 4°C using Metal Cooler and 2-3 Ice Packs
DDT,DDD,DDE	One 1-quart glass bottle, narrow neck w/Teflon®-lined cap	Unfiltered	None	Yes

® Teflon is a registered trademark of E. I. DuPont de Nemours and Co., Inc., Wilmington, DE. Use of trademarked name does not imply endorsement by the US Army, but is intended only to assist in identification of a specific product.

TABLE F-2. ANALYTICAL METHODS

Parameter	Methodology
DDT	EPA 608*
DDD	EPA 608*
DDE	EPA 608*

* "Method of Organic Chemical Analysis of Municipal and Industrial Wastewater", EPA 600/4-82-057, July 1982

4. QUALITY ASSURANCE. Quality assurance will be performed using the procedures outlined in the Manual for the Certification of Laboratories Analyzing Drinking Water, Criteria and Procedures, Quality Assurance, EPA-570/9-82-002, October 1982.